West Virginia Mining Permit Boundary Data (d*raft)*

Description

The permit boundary layer depicts bonded areas associated with mining permits regulated under the Surface Mining Control and Reclamation Act (SMCRA) of 1977. Bonded areas typically include 1) mineral removal areas, where mineral extraction occurs; 2) disturbed areas, most notably refuse disposal areas, such as valley fills, and roads; and 3) drainage structures, including ditches and ponds primarily designed to control runoff and sediment.

Permits are required for both surface and underground mines. Note, however, that the bonded areas for underground mines only represent areas of surface disturbance, such as entry portals (the face-up area), ventilation shafts, and access roads. The permit boundary for an underground mine does not represent the extent of underground workings. In addition to surface and underground mines, boundary information also is captured for preparation plants, haul roads, refuse disposal facilities, loading facilities, and quarries. It is not uncommon for permit areas to overlap.

Completeness

This dataset does not represent a complete record of mining activity, since considerable mining occurred prior to federal regulation in 1977. Other gaps in the data exist because many early permit maps were discarded after regulatory authority ended.

The current goal of this project is to acquire boundary information for all permits that currently are active, being reclaimed, or not started. The dataset also may include permits that are awaiting approval. A secondary goal is to capture boundaries for closed and released permits, contingent on map availability and personnel resources. Boundary information already exists for many older permits, which has been included in the dataset. However, the overall completion percentage is significantly lower than for active permits.

A comparison of available permit boundaries with records in the Division of Mining & Reclamation's Oracle database, undertaken on August 18th, 2006 indicated the following:

permit status	total	with bdy	pct
new/renewed	1325	1321	99.7%
phase release	435	433	99.5%
inactive	231	231	100.0%
revoked	1116	247	22.1%
completely released	3247	757	23.3%

The comparison excludes Prospects, Wildcat operations, and Complaint types. As of the above date, archival material was exhausted and all new permits had been entered into the database. Currently, new permits will be added as they are received by the Charleston office.

Mining permits often are modified, revised, amended, renewed, or become inactive. Various events generate new maps to reflect changes in the permit. The project goal is to update boundaries during permit renewal (every 5 years) and upon release (final map). Major modifications to the permit boundary also should be captured. Minor changes to the permit boundary, known as incidental boundary revisions, will not be captured. A secondary goal is to maintain a boundary history that captures major permit milestones (new, renewed, released) as well as events that produce significant boundary modifications. At this time, an unknown number of boundaries in this database are out of date due to subsequent modification. Currently, processes have been put into place to update boundaries when major modification events occur.

Data Compilation

The initial dataset was compiled from individual permit boundaries that were digitized under contract to an outside party. After the contract ended, WVDEP invested approximately 120 hours in error checking and correcting the initial composite version of the dataset. Since permit boundaries typically conform to landscape and cultural features, visual inspection of the data over hillshade and topographic map backgrounds often revealed position and scale problems. Additionally, disagreement along shared permit boundaries sometimes indicated errors that required attention. Approximately 50 permits were georeferenced and digitized again to correct significant positional errors, while approximately 25 more were modified to correct for smaller errors.

Following the initial error correction phase, WVDEP instituted procedures to update and maintain the dataset, which are described in detail below.

Source Maps

Most source maps usually are folded paper in a wide range of sizes, up to 36 inches in width. These maps are scanned on a large format scanner at 100-200 dpi. Internal scans made by the WVDEP are 200 dpi high-quality JPEG images. Maps scanned at 100 dpi were produced under contract to a document imaging service. These maps generally are usable, but sometimes present readability problems for small text and complex features. More recently, source maps have been delivered in Adobe PDF, which easily can be converted to common image formats, and AutoCAD DWG. Contrary to common assumption, the DWG format has proven difficult to work with, because boundary features invariably are not isolated layers that can be extracted easily and appended to the existing database. It has proven more efficient to convert the DWG file to a common image format (using a converter program), then rectify the image and digitize the feature in the usual way.

Source map quality varies widely. Older permits sometimes appear to be hand drawn with colored pencil on a blueprint or photocopy of a USGS 1:24,000 quadrangle map. Other maps from the same era depict the outlines of buildings, roads, and other features in detail that match precisely with contemporary large-scale orthophotography. Most newer permit maps are compiled using AutoCAD, using a combination of USGS and/or orthophoto-derived layers to depict elevations, roads, streams, and buildings. AutoCAD maps present an appearance of precision. However, experience has demonstrated that a source map's precise appearance does not necessarily correlate with it's accuracy.

Image Rectification

Georeferencing standards developed for this project specify 6 or more well distributed tie-points to one or more of these reference layers—

1) a state plane coordinate grid
2) 2-foot orthophotography, with a 1:4,800 accuracy standard
3) 1-meter NAPP orthophotography
4) 1:24,000 USGS DRG topographic maps

A first order transformation is used, since experience has shown that tie-point distribution makes it difficult to produce second or third order rectifications with any degree of confidence.

ESRI Arcmap is used for image rectification, which provides for semi-transparent overlay of the permit map over the reference layers. The image is warped in real-time as each tie-point is added, which provides instant visual feedback of how well the image is conforming to the reference layers.

The tie-point selection process is largely dependent on features shown on the permit map. In order of preference, the following features are used when available—

1) Coordinate grids are used if they do not produce observed systematic offsets relative to the reference layer. Where coordinate grids are used, the addition of tie-points that use other features, such as buildings or road intersections, should not introduce exceptional errors into the transformation. This ensures that the coordinate grid is properly aligned with the map features, which is not always the case.

2) Building outlines, apparently derived from orthophotography, are matched to one of the photography reference layers. Paved roads and jeep tracks that were derived in the same manner provide good supplemental points. Single story buildings are preferable. Silos and towers also are sometimes used, with attention paid to use the base of the structure.

3) Photocopies and blueprints of USGS topographic maps can be precisely matched to DRG (digital topographic map) products with excellent results. Contour lines provide many potential tie points and visual conformation of a match between the permit map and the reference quadrangle. Observed problems include poor alignment along quadrangle boundaries of up to 25 meters, resulting in unacceptable error when tie points are taken from both sides of the quadrangle boundary.

4) CAD layers derived from USGS topographic map features usually produce excellent alignment with a DRG background. However several cases have been discovered where individual map layers are not aligned to each other. For example, using contours as tie points may cause a systematic offset of roads, buildings, and streams.

These four categories account for the majority of permit maps processed. However, numerous difficult cases exist. For example, some maps include very few cultural features and utilize proprietary elevation contours, which permit only general alignment with topographic features, such as hilltops and valleys. Other maps may depict roads and building locations in a less than rigorous manner, making it difficult to produce a low-error transformation.

Digitizing

Permit boundaries are digitized on-screen using the rectified permit map. Digitizing of features on screen is performed 1:4,000 scale or better for large surface mines, and 1:2,500 or better for detailed features such as haul roads, underground mine face-up areas, and prep plants.

Error Sources

Error is difficult to evaluate because a mining proposal map essentially defines a feature that does not yet exist. Therefore, a representative sample cannot be compared against a more accurate reference source to estimate error. Rather, the map guides the operator (and the regulator) during activity that *creates* the feature. The precision with which an operator is required to follow the map is a question of regulatory policy. In practice, inspectors largely rely on visual inspection of the site; they generally do not use high accuracy data sources such as GPS or aerial photography. So the conformance between the boundary polygon and the disturbed area on the ground cannot be defined with reliable certainty.

Error induced during the database development process—scanning, georeferencing, and digitizing—compound upon any existing errors in the source document associated with improper positioning or scaling of various layers. This *original* error is manifested in a variety of ways, including data not matching properly at a seam (figure 1), or a layer that is scaled or positioned in such a way that it does not match other layers (figure 2), or building outlines that do not match ground conditions (figure 3).

Figure 1. mismatch in contour layers used to produce a permit map.

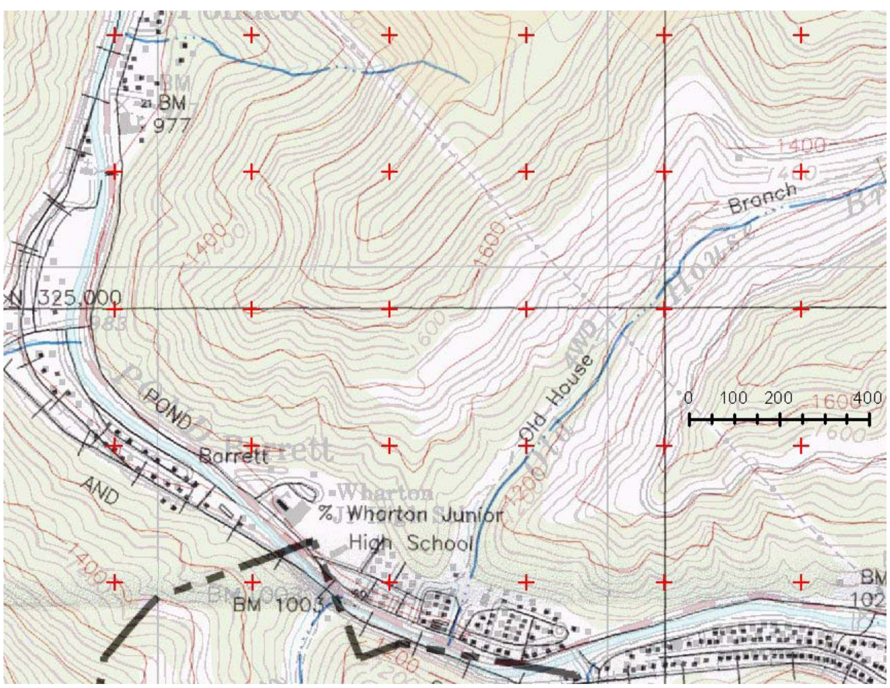


Figure 2. contour layer on this CAD-based map is misaligned with other features.

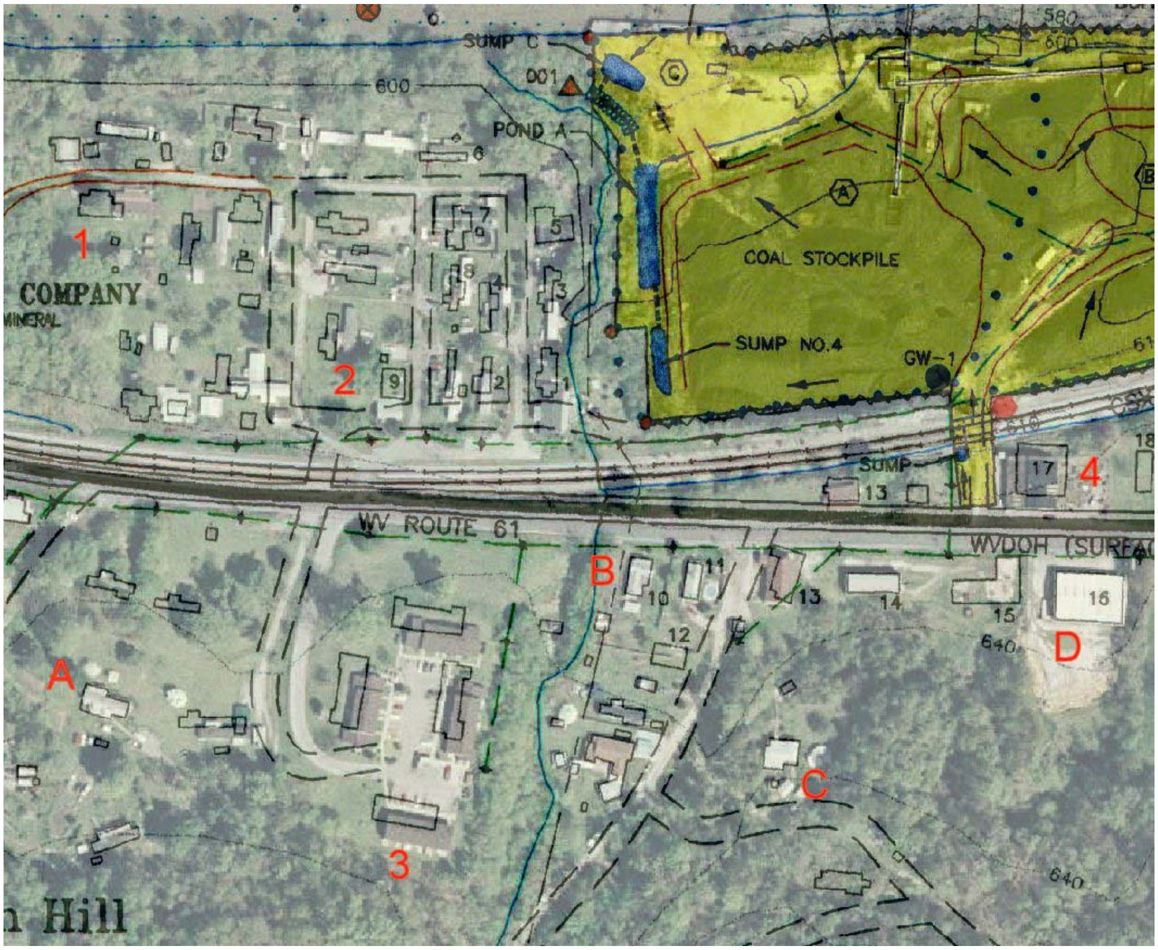


Figure 3. precisely rendered buildings match ground conditions at points A-D, but are misplaced at points 1-3 (and others) in a non-systematic pattern.

Careful examination of the source map can avoid observable errors during the georeferencing process, but non-apparent errors represent an unknown quantity of original error existing before any processing has occurred. *Process* error compounds original error during the conversion of the source material to a digital representation. Processing error is associated with scanning , georefeencing, and digitizing.

Scanning Error

1) distortion in the source map due to paper anomalies, such as folds.
2) scanner errors, such as slips,

Georeferencing error

1) inadequate number of common points between the source map and the reference layer,
2) non-uniform distribution of control points throughout the map.
3) imprecise digital rendering of potential control points, e.g., lines that are several pixels wide
4) use of 'soft' control points, such as bends in roads and streams, hilltops, or roads and railroad intersections with acute angles.

Digitizing error

1) scale the source map is displayed when digitizing.
2) diligence shown by the digitizing technician in accurately following a boundary, including accurate placement of vertices and using sufficient vertices to describe curvature and complex shapes.
3) the clarity with which the boundary is depicted on the map, which is influenced by the resolution of the original scan, image compression artifacts, clutter on the original map from other features.
4) accurate interpretation of the map legend.

## Appendix A	Attributes

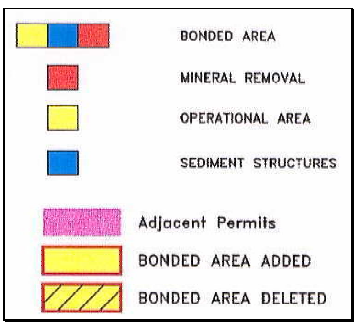
PERMIT_ID	unique permit identifier. First letter usually is indicative of mine type, e.g. u—underground, s—surface, q—quarry, h—haulroad, etc. for permits issued since the early 1990s, the second position indicates the DEP region (1-5), positions 3-5 are a sequential number indicating the nth permit received in a particular year, and positions 6-7 indicate the year.
MAPDATE	date of the source map used to create the feature
APPTYPE	permit activity associated with the source map ibr incidental boundary revision ina inactive status sma surface mining application (new permit) ren permit renewal rel final release rev revision oth other/unknown
MAPTYPE	type of map sued to create the boundary pr proposal map pd proposal drainage map rp renewal progress map fi final map is inactive status map sc subsidence control plan dr drainage map ge geologic map ot other
SHEETNO	map sheet
MF_TYPE	internal processing code
ACTIVE_VIO	active violations, at the time the data was created
TOTAL_VIO	total viloations, at the time the data was created
MSTATUS	inspection status A1 A1-Active, Moving Coal Possible A2 A2-Active, Reclamation only A3 A3-Active, Reclaimed A4 A4-Active, No coal removed AM AM-Active, Moving Coal AQ AQ-Active Quarry IA IA-Approved inactive Status UK UK-Unknown NS NS-Not Started P1 P1-Phase 1 release (backfill/grading) P2 P2-Phase 2 release, revegetated PG PG-Prospecting > 250 tons PR PR-Prospecting < 250 tons PV PV-Phase1 release(60%revegetation or MR-1 RC RC-Reclaimed, but Chemical treatment of w

	NONE None Available
EPERMIT_ID	same as PERMIT_ID
SR1	internal processing code
SR2	internal processing code
SR3	internal processing code
SR4	internal processing code
SR5	internal processing code
SR6	internal processing code
FACILITY_N	facility name
OPERATOR	operator name
PERMITTEE	permit granted to
UPDATE_DAT	date the feature was added/modified
ACRES_ORIG	acres permitted originally
ACRES_CURR	acres permitted currently
ACRES_DIST	acres disturbed
ACRES_RECL	acres reclaimed
SHAPE_AREA	area of feature, m^2
SHAPE_LEN	perimeter, in meters
legend	interactive map legend code

Appendix B Permit Map Legends

Bonded areas are shown on several types of maps submitted with a permit application. The most commonly used maps are proposal maps, which typically have a legend similar to figure 1, in which mineral removal areas are shown in red, other disturbed areas are shown in yellow, and drainage structures blue.

Maps associated with permit modifications may contain additional categories depicting areas added or removed from the original permit (figure 2). These additional legend categories are not standardized.



Maps associated with permit renewals or final maps include categories for undisturbed and reclaimed (or regraded) areas, the latter of which is usually shown in green (figure 3).